ENGINEERING

Circuit2 First

Circuit2

30/03/2011

90 min

التخصص والمستوى :

اسم المساق :

تاريخ الامتحان :

زمن الامتحان :

السلطة الوطنية الفلسطينية

جامعة فلسطين التقنية طولكرم"خضوري"

first exam 2010/2011

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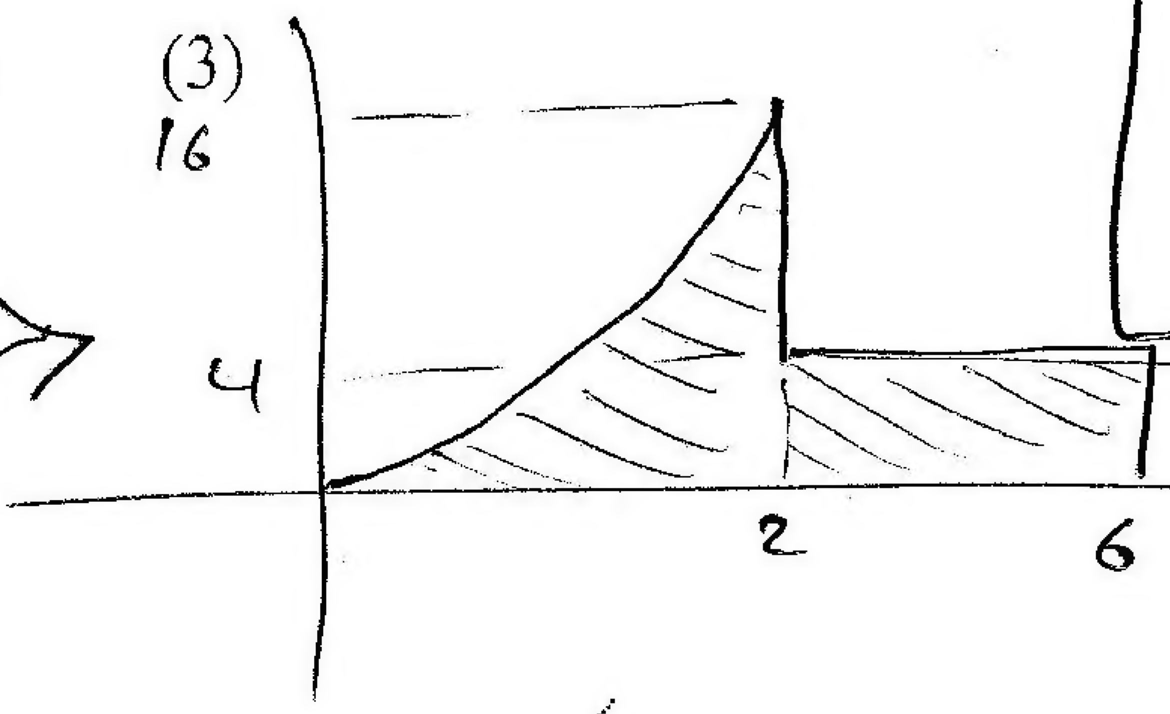
21

الاسم : معن سلام فقدان

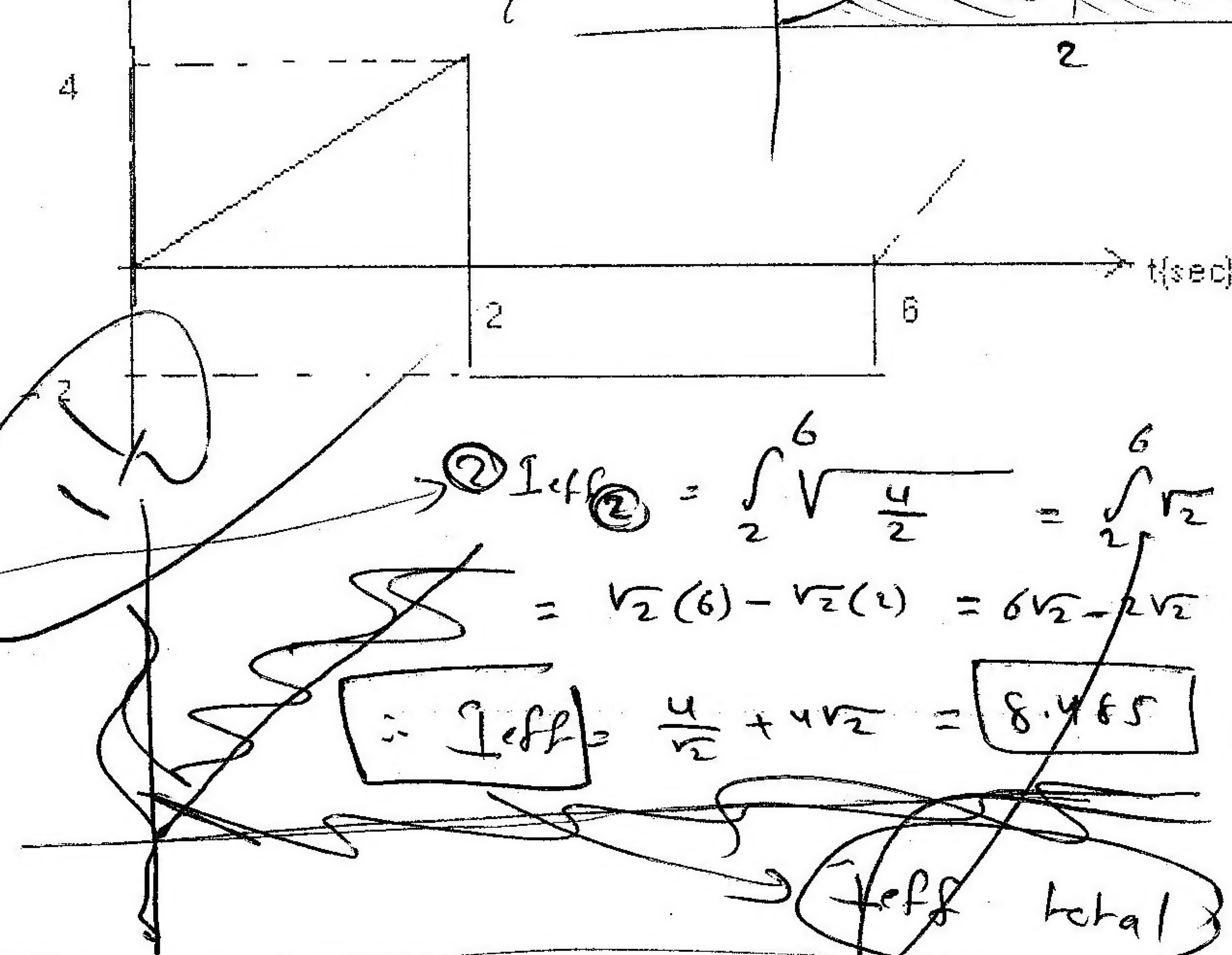
الشعبة : اثنين اربعاء 8-9:30

العلامة $\frac{21}{30}$

Q1) a)Find the RMS value of the following periodic waveform (3)



$\boxed{I_{eff} = \frac{i(t)}{\sqrt{2}}} = \int_a^b \sqrt{\frac{i^2(t)}{2}}$



* $i(t)\ (0<t<2) = \boxed{2t}$

* $i(t)\ (2<t<6) = \boxed{-2}$

$\Rightarrow i^2(t)\ (0<t<2) = \boxed{4t^2}$

$\Rightarrow i^2(t)\ (2<t<6) = \boxed{4}$

① $I_{eff_1} = \int_0^2 \sqrt{\frac{i^2(t)}{2}} = \int_0^2 \sqrt{\frac{4t^2}{2}}$

$= \int_0^2 \sqrt{2}\, t = \int_0^2 \sqrt{2}\frac{t^2}{2} = \frac{t^2}{\sqrt{2}} \Big|_0^2$

$= \frac{4}{\sqrt{2}} - 0 = \boxed{\frac{4}{\sqrt{2}}}$

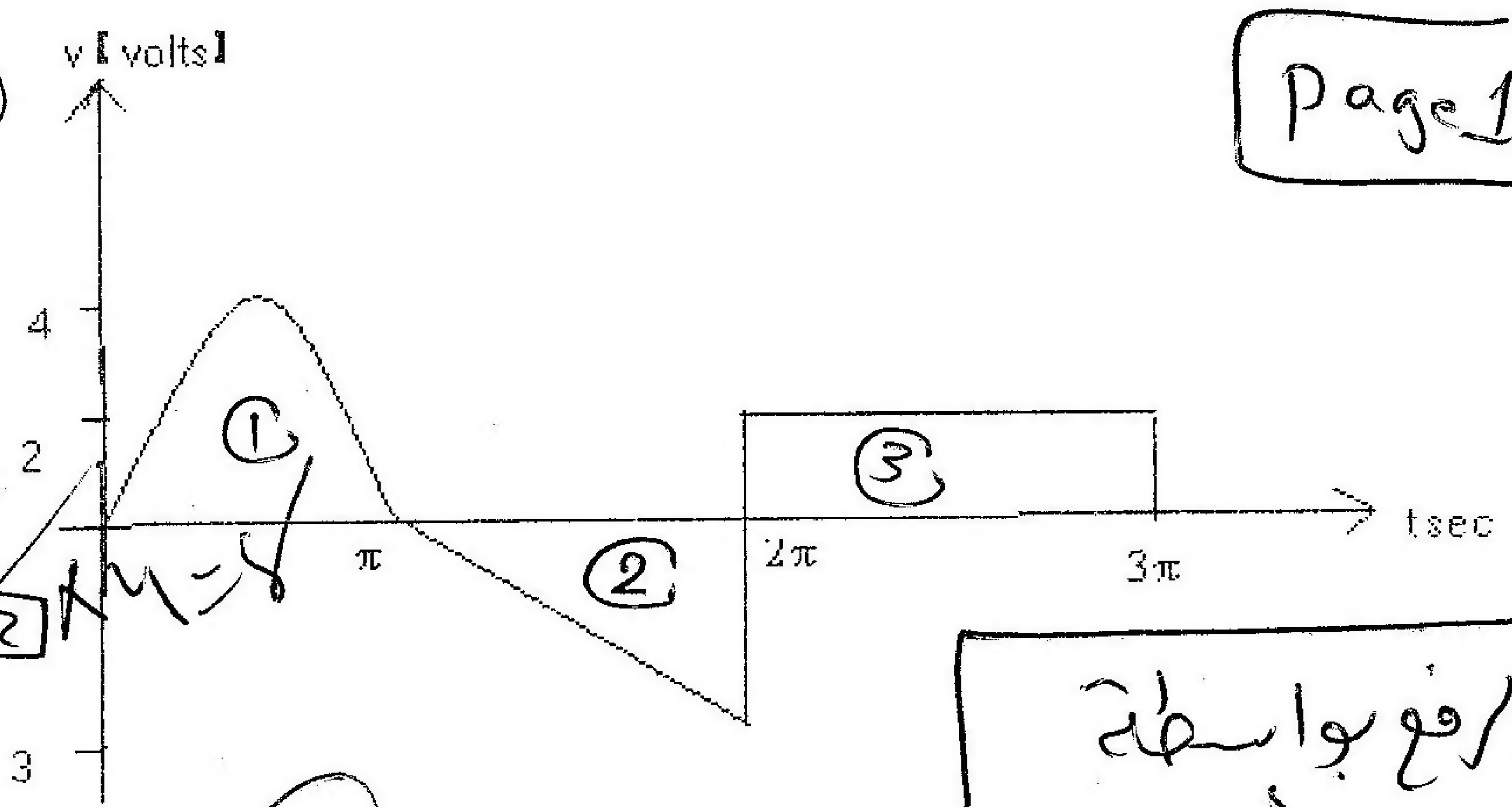
② $I_{eff_2} = \int_2^6 \sqrt{\frac{4}{2}} = \int_2^6 \sqrt{2} = \sqrt{2}\, t \Big|_2^6$

$= \sqrt{2}(6) - \sqrt{2}(2) = 6\sqrt{2} - 2\sqrt{2} = \boxed{4\sqrt{2}}$

$\boxed{\therefore I_{eff} = \frac{4}{\sqrt{2}} + 4\sqrt{2}} = \boxed{8.485}$ A

Ieff total

b)Find the average value of the following periodic waveform (3)



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$V_{avg} = \frac{1}{T}$ (area under the curve)

area ① :-

$\int_0^{\pi} \sin t\, dt = -\cos \Big|_0^{\pi}$

$= -\cos\pi - (-\cos(0))$

$= (--1) - (-1) = 1+1 = \boxed{2}$

area ② : $\frac{1}{2}(2\pi - \pi)(3)$

$= \frac{1}{2}\pi(3) = \boxed{\frac{-3\pi}{2}}$

area ③ :- $(3\pi - 2\pi)(2) = \boxed{2\pi}$

تم الرفع بواسطة م. معن ابو عيسى

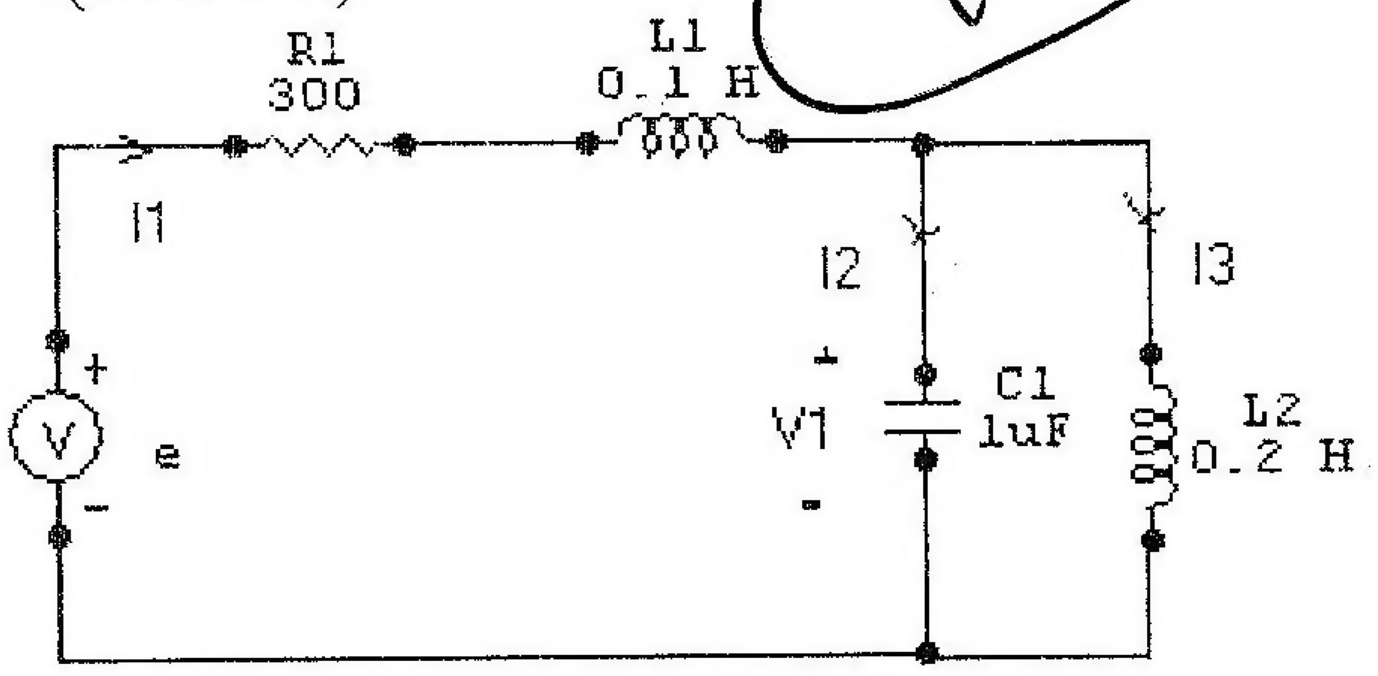
$\therefore$ area under the curve $= 2 + \frac{3\pi}{2} + 2\pi = \frac{4}{2} + \frac{3\pi}{2} + \frac{4\pi}{2} = \boxed{2 + \frac{7\pi}{2}}$

$\therefore V_{avg} = \frac{1}{3\pi}\left(\frac{2}{1} + \frac{7\pi}{2}\right) = \frac{1}{3\pi}\left(\frac{4+7\pi}{2}\right) = \boxed{\frac{4+7\pi}{6\pi}} = \boxed{\frac{2}{3\pi} + \frac{7}{6}}$

Q2)In the circuit shown below if e= 50sin(2π1000t)

$$\boxed{e = \frac{50}{\sqrt{2}} \angle 0^\circ = 35.35 \angle 0^\circ}$$

a



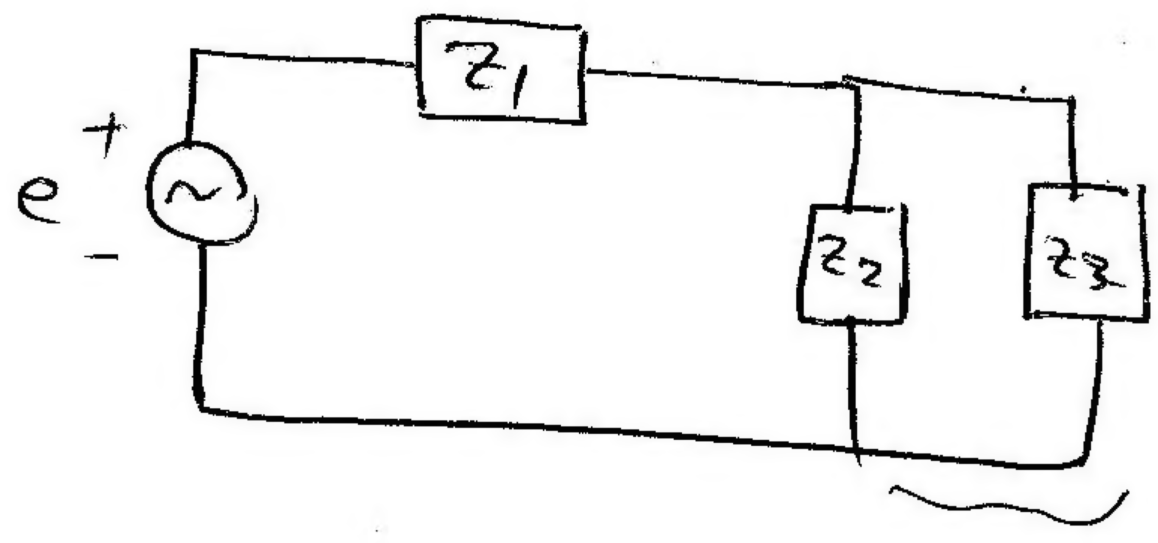
$P_{avg} = VI \cos(\theta_v - \theta_i)$

a)Find the total impedance (Z_T) and total admittance (Y_T) (2.5)
b)Find the total current (I1) (1)
c)Find i3(t),i2(t) and v1(t) (3)
d)Find the average power delivered to the circuit (1.5)
e)Find the power factor of the circuit and indicate whether it leading or lagging (1)

$X_{L1} = \omega L_1 = 2\pi \times 1000\ (0.1) = 628\ \Omega$

$X_{L2} = \omega L_2 = 2\pi \times 1000\ (0.2) = 1256.6\ \Omega$

$X_{C1} = \frac{1}{\omega C} = \frac{1}{2\pi \times 1000 \times 1 \times 10^{-6}} = 159$



a) $Z_1 = (300 + j628)\ \Omega$

$Z_2 = -j159\ \Omega$

$Z_3 = j1256$

$Z_2 // Z_3 = \frac{-j159 \times j1256}{1256j - 159j} = \frac{199704}{1097j} = 182 \angle -90^\circ = \boxed{-j182}$

$\therefore Z_T = Z_1 + (Z_2 // Z_3) = 300 + j628 - j182 = 300 + j446$

$\therefore Z_T = \boxed{537.5 \angle 56^\circ}$

$\therefore Y_T = \frac{1}{537.5 \angle 56^\circ} = \boxed{0.00186 \angle -56^\circ \text{ Siemens}}$

b) $I_T = \frac{E}{Z_T} = \frac{35.35 \angle 0^\circ}{537.5 \angle 56^\circ} = \boxed{0.065 \angle -56^\circ \text{ A}} = \boxed{I_1}$

c) $I_2 = I_1 \frac{j1256.6}{j1256.6 - j159} = 0.065 \angle -56^\circ \left[\frac{j1256.6}{j1097}\right] = \boxed{0.074 \angle -56^\circ \text{ A}}$

$i_2(t) = 0.074(\sqrt{2}) \sin(2\pi \times 1000t - 56^\circ) = \boxed{0.104 \sin(2\pi \times 1000t - 56^\circ)}$ A

$I_3 = I_1 \frac{-j159}{j1256 - j159} = I_1 \frac{159 \angle -90^\circ}{1097 \angle 90^\circ} = 0.065 \angle -56^\circ \left[0.145 \angle -180^\circ\right] = \boxed{0.00942 \angle -236^\circ \text{ A}}$

$i_3(t) = 0.00942\sqrt{2} \sin(2\pi \times 1000 - 236^\circ) = \boxed{0.0133 \sin(2\pi \times 1000t - 236^\circ)}$ A

$V_1 = I_2 Z_2 = 0.074 \angle -56^\circ \times 159 \angle -90^\circ = \boxed{11.766 \angle -146^\circ}$ V

$v_1(t) = 11.766\sqrt{2} \sin(2\pi \times 1000 - 146^\circ) = \boxed{16.63 \sin(2\pi \times 1000 - 146^\circ)}$ V

(d) $P_{avg} = I\,V\cos(\theta_v - \theta_i)$

$\cancel{= 0.065\angle -56^\circ \times 35.35\angle 0^\circ \cos(0 - -56)}$

$= 0.065 \times 35.35 \cos(0 - -56)$

$= 0.065 \times 35.35 \cos 56^\circ$

$= 1.284$ Watt

(e) $F_p = \cos(\theta_v - \theta_i) = \cos 56^\circ = \boxed{0.56}$

It's lagging Power factor

Inductive Network

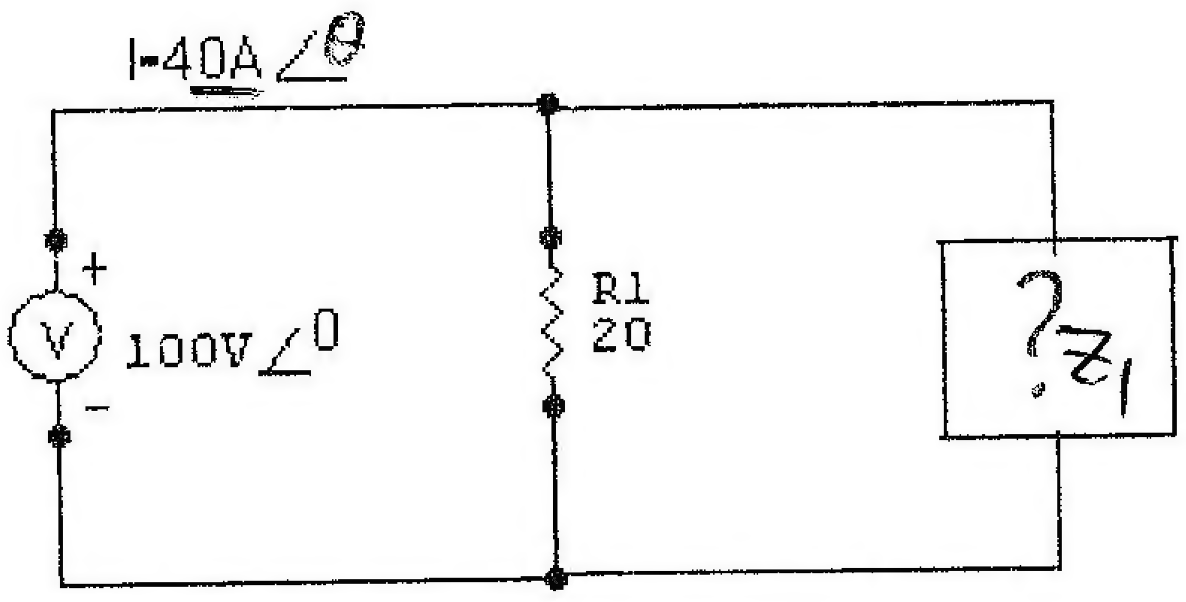
Q3)Find the element or elements that must be in the closed box in the circuit to satisfy the following Conditions:

1)Average power to the circuit is 3000 W

2)Circuit has a leading power factor

3

(5)



① $P_{avg} = IV\cos\theta$

~~3000~~

$\therefore \cos\theta = \dfrac{P_{avg}}{IV} = \dfrac{3000}{40(100)} = \dfrac{3000}{4000} = \boxed{0.75}$

$\therefore \theta = \cos^{-1}(0.75) = \boxed{41.4^\circ}$

② ⇒ leading Power factor

$\Rightarrow \boxed{\therefore\ I = 40\angle 41.4^\circ\ A}$

$\therefore$ Capacitive Network

$\therefore$ The element must be a capacitor

$\therefore Z_T = \dfrac{V_T}{I_T} = \dfrac{100\angle 0}{40\angle 41.4^\circ} = \boxed{2.5\angle -41.4^\circ\ \Omega}$ Capacitor

$\cancel{= 2.5(\cos 41.4^\circ - j\sin 41.4^\circ)}$

$\cancel{Z_T = \dfrac{20 Z_1}{20 + Z_1}}$ $\cancel{= 2.5(0.75 - j0.66) = 1.875 - j1.65}$

$\cancel{\therefore 1.875 - j1.65 = \dfrac{20 Z_1}{20 + Z_1}}$

$\cancel{(1.875 - j1.65)(20 + Z_1) = 20 Z_1}$

$\cancel{37.5 + 1.875 Z_1 - j33 - j1.65 Z_1 = 20 Z_1}$

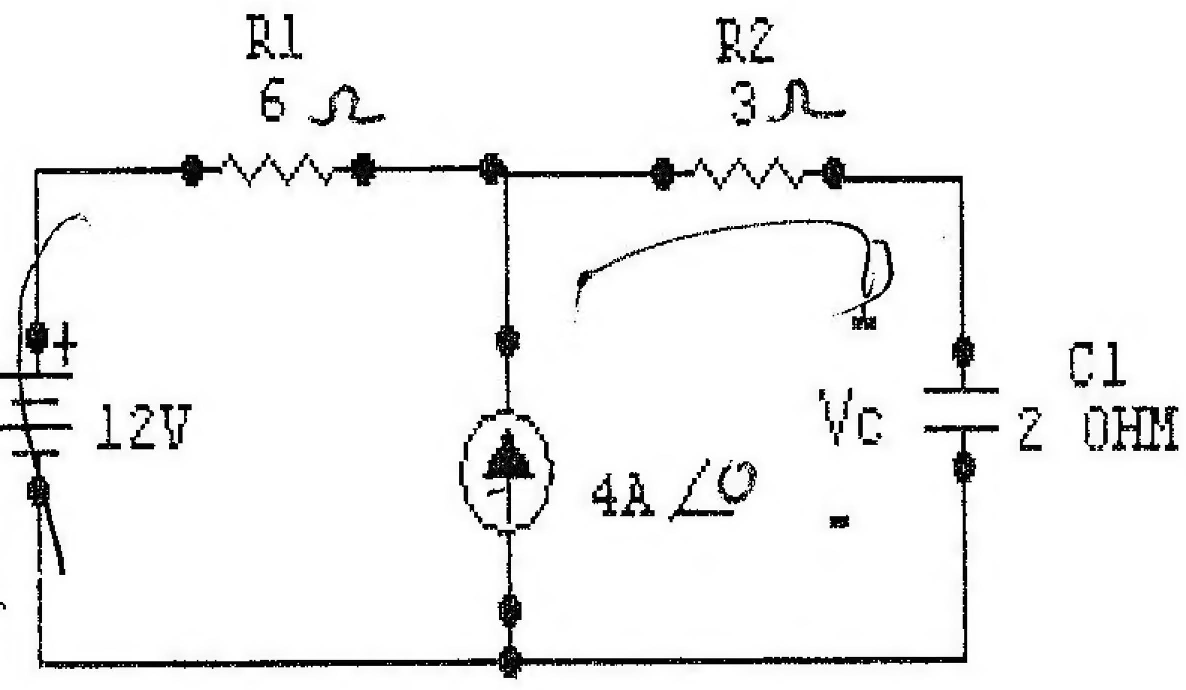
$\cancel{(37.5 - j33) + (1.875 Z_1 - j1.65 Z_1) = 20 Z_1}$

Q4)Using superposition find the sinusoidal expression for the voltage Vc in the circuit below (4)

Using superposition

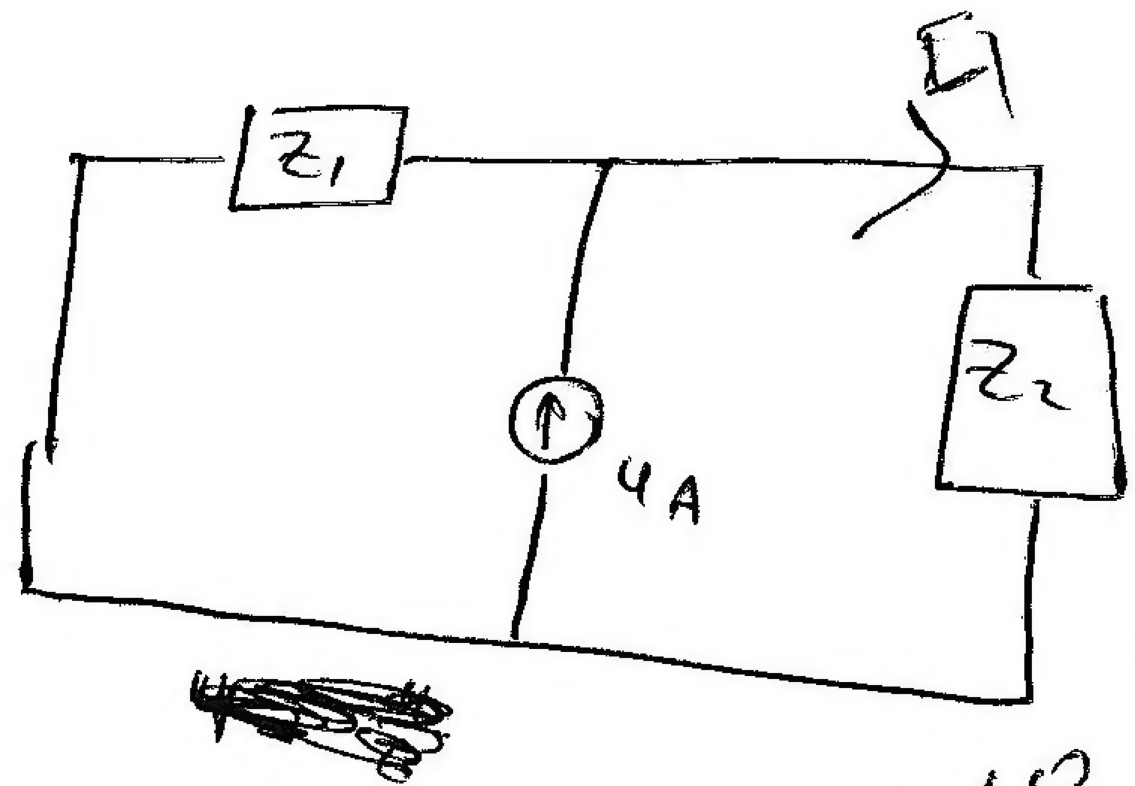
① From 12 V Source

$V_{c_1} = 12\ V$



DC

② from 4A Source



$Z_1 = 6\ \Omega = \boxed{6\angle 0^\circ}$

$Z_2 = 3 - j2$

$= \boxed{3.6\angle 33.6^\circ}$

$I_1 = 4\angle 0 \quad \frac{Z_1}{Z_1 + Z_2}$

$\therefore V_{c2} = I_T \times Z_2$

$= 4\angle 0^\circ \times 3.6\angle 33.6^\circ = \boxed{14.4\angle 33.6^\circ\ V}$

$\therefore V_c = V_{c_1} + V_{c2} = 12\ V + 14.4\angle 33.6^\circ\ V$

$= 12 + 14.4(\cos 33.6^\circ + j\sin 33.6^\circ)$

$= 12 + 14.4\cancel{(0.83 + j0.55)}$

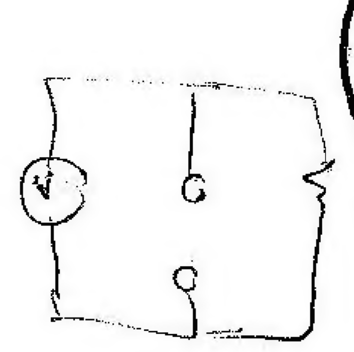
$= 12 + 11.952 + j7.92$

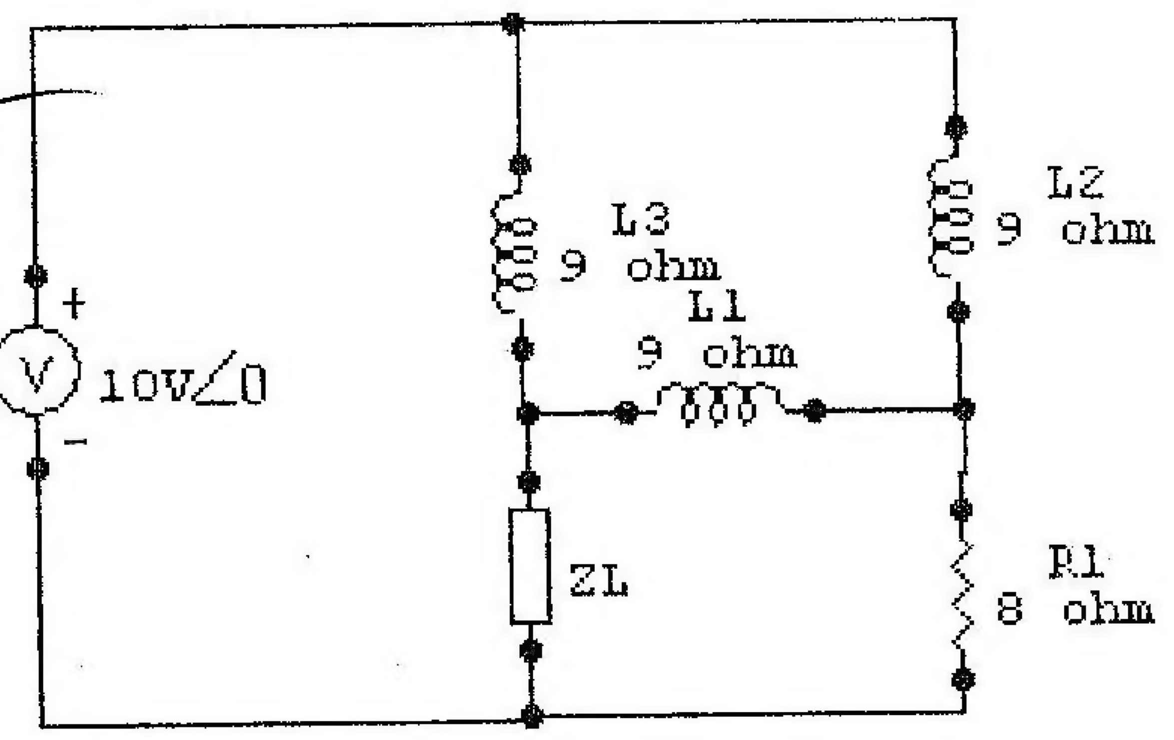
$= 23.952 + j7.92 = 25.2\angle 18.2^\circ\ V$

$\therefore V_c(t) = 25.2\sqrt{2}\sin(18.2^\circ) = \boxed{35.6\sin 18.2^\circ}$

$Y = \frac{\Delta}{3}$

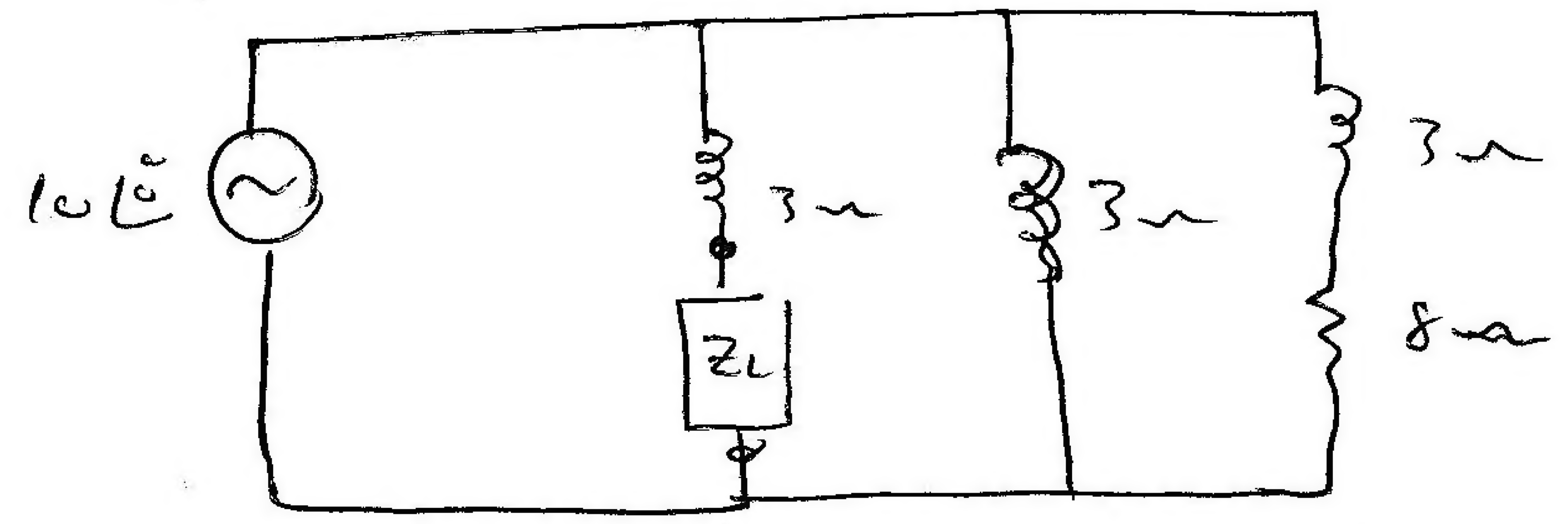
Q5)Find Z_L for maximum power transfer and find the maximum power (6)

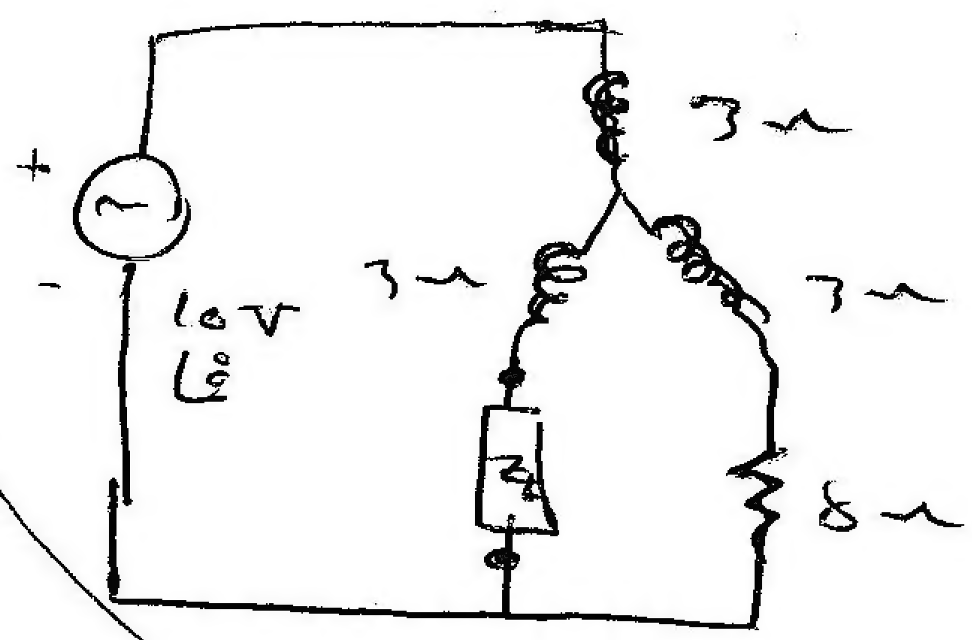




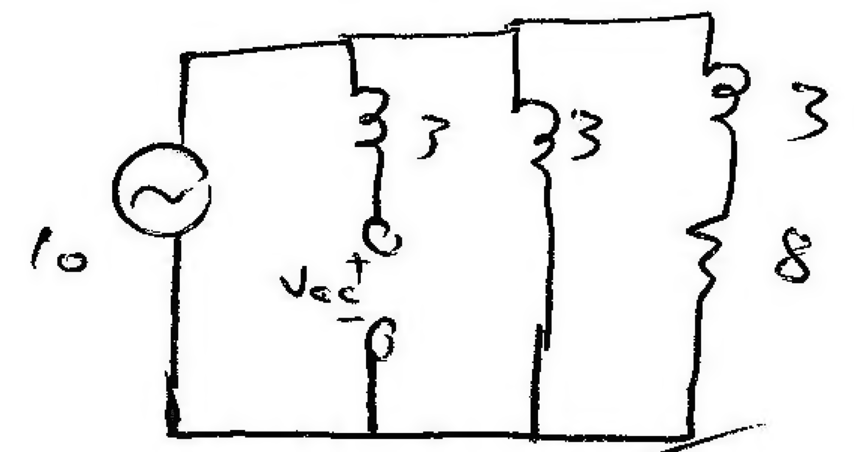
$Y = \frac{\Delta}{3} = \frac{9}{3} = \boxed{3\Omega}$

$\Rightarrow$

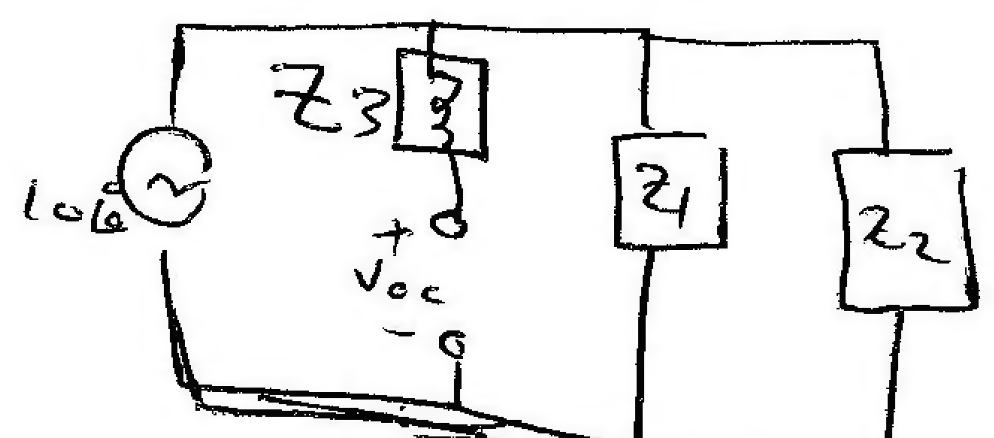




① Find Voc



$\Rightarrow$



$Z_1 = j3 = \boxed{3\angle 90^\circ}$

$Z_2 = 8 + j3 = \boxed{8.5\angle 20.5^\circ}$

$\therefore V_{oc} = \boxed{10\ V} = 10\angle 0^\circ$

$Z_{eq} = \boxed{Z_1 // Z_2 + Z_3}$

$$Z_1 // Z_2 = \frac{3\angle 90^\circ \times 8.5\angle 20.5^\circ}{j3 + 8 + j3} = \frac{25.5\angle 110.5^\circ}{8 + j6} = \frac{25.5\angle 110.5^\circ}{10\angle 36.8^\circ}$$

$$= \boxed{2.55\angle 73.7^\circ}$$

$\therefore Z_{eq} = (Z_1 // Z_2) + Z_3 = 2.55\angle 73.7 + 3\angle 90^\circ$

$= 2.55\ (\cos 73.7 + j\sin 73.7^\circ) + j3$

$= 2.55\ (0.28 + j0.96) + j3$

$= 0.714 + j2.448 + j3 = \boxed{0.714 + j5.448}$

Good Luck
Mahmoud Ahmad

$\boxed{1}$ $\therefore Z_L$ for maximum power transfer $= Z_{eq}^* = \boxed{0.714 - j5.448}$

$\boxed{2}$

$\Rightarrow$ Maximum Power transfer

$$= \frac{V_{TH}^2}{4R} = \frac{(10)^2}{4(0.714)} = \frac{100}{2.856}$$

$$\approx \boxed{35 \text{ watt}}$$